



## Genus *Cyptophania* Banks (Psocodea: 'Psocoptera': Lepidopsocidae): unique features, augmented description of the generotype, and descriptions of three new species

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### Abstract

We define the genus *Cyptophania* with characters that clearly separate it from other genera of the Family Lepidopsocidae in which wing reduction has occurred. We redescribe the generotype, *C. hirsuta* Banks (Hawaii, presumably introduced), and describe three new species, *C. australica* n.sp. (Queensland, Australia), *C. costalis* n.sp. (Gulf of Mexico and Caribbean), and *C. pakaratii* n.sp. (Rapa Nui = Easter Island, probably endemic). The latter species is described from both sexes and presents the first males known for the genus. One female of this species presents a large spermatophore protruding from the genital chamber, thus indicating the mode of sperm transfer in sexual members of this genus. A key to the known species is included. All of the species of *Cyptophania* are highly neotenic, but differences in the level of neoteny are noted among the species studied. We question the synonymy of the genus *Ptenocorium* Enderlein with *Cyptophania* on the basis of several characters illustrated in the original description of *Ptenocorium*. We note similarities of *Cyptophania* to the entirely macropterous genus *Lepidopsocus* Enderlein and suggest a possible close relationship between the two genera.

**Key words:** New species, neoteny, Pacific Basin, Easter Island, Hawaii, Queensland, Gulf and Caribbean

### Introduction

In the Psocodean Family Lepidopsocidae, several genera have been proposed based on forms in which the wings are reduced, often with various degrees of loss of venation, and in some cases with complete loss of hind wings. Most of these genera have been established on the basis of very few characters, and it is sometimes difficult to decide where to place particular infrageneric taxa.

The genus *Cyptophania* Banks (1931) is one of these genera with reduced wings. It is a small group with only a few known species, restricted to tropical and subtropical parts of the world and found mostly on islands and continental seashores. The group must be viewed as poorly known at present. Descriptions of the known species have been extremely superficial. In this paper we provide new characters for recognition of the genus, clearly separating it from other lepidopsocid taxa with reduced wings. We also provide an evaluation of characters for species recognition, redescribe the generotype, *Cyptophania hirsuta* Banks, and describe three new species. Some of the most important characters for separating species have proven to be structures not ordinarily examined in detail in the Psocoptera, such as the collar of the spermathecal duct, internal and surface features of the spermathecal sac, and several characters of the hind leg.

One of our new species, *C. pakaratii* n. sp., is the first *Cyptophania* to be represented by both sexes, thus first revealing male characters. This species has a much larger and less wrinkled spermathecal sac than the other species studied, and on that account (and for lack of males), we suspect that all of the others are parthenogenetic.

## Materials and methods

The material consists of 14 adult specimens of the new species from Easter Island (Rapa Nui), 3 adult specimens of the new species from Queensland, 10 adult specimens of the new species from the Gulf-Caribbean region, and 3 adult specimens of the type species, *C. hirsuta*, from Hawaii. Holotypes will be deposited in the collection of the Illinois Natural History Survey, Champaign, Illinois (INHS). Where possible, paratypes will be deposited in the collection of ELM, currently housed in the School of Biological Sciences, Illinois State University, Normal, Illinois (ELM).

Illustrations were made with the aid of a drawing tube. Measurements, expressed in  $\mu\text{m}$ , were made with a filar micrometer. Body lengths and head measurements were taken on whole specimens held in place on fine sand, with a dissecting microscope. Other measurements were made on slide-mounted parts. Color descriptions are based on observations through a dissecting microscope with direct light on specimens preserved in 80–95% ethyl alcohol for stated periods of time.

Abbreviations used in the descriptions are explained as follows: BL = body length; for head: d = lateral diameter of compound eye in anterior view, D = dorso-ventral diameter of compound eye in anterior view; fn = a specific antennal flagellomere and its length; IO = least distance between compound eyes in anterior view; Pn = a particular segment, 1–4, of the maxillary palpus; for legs: F = hind femur length, T = hind tibia length, t1–t3 = first to third hind tarsomeres and their lengths measured condyle to condyle; for ovipositor: v1 = the small valvula with base arising from the larger valvula (Figs 12, 26, 32, 43) and consisting in part in fibers in membrane, v2 + 3 = the large, setose, valvula (Figs 12, 26, 32, 43), here assumed to be formed by fusion of v2 and v3; fore wings: FW = fore wing length (hind wings not measured).

## Systematics

### Genus *Cyptophania* Banks

#### *Cyptophania* Banks (1931)

*Pteroxaniella* Karny (1932). Synonymy Roesler (1944)

?*Ptenocorium* Enderlein (1931). Synonymy Thornton *et al.* (1972) (See discussion)

**Diagnosis.** Adults markedly neotenic, exhibited in following characters: brachyptery with fore wings not or barely reaching tip of abdomen (Fig. 1); hind wings reduced to small button-like swellings (Fig. 3) or slender strips (Fig. 4); ocelli absent; mesocoxal interlocking mechanism absent (see Menon 1938); rasp of hind coxal organ reduced (Figs 10, 18, 29, 39–41); trichobothrium-like setae of hind tibia sometimes present (Fig. 30; these are strictly nymphal structures in some macropterous Lepidopsocidae, see Discussion); paraproctal sensorium reduced to two trichobothria on basal florets (Fig. 7).

Note. Some of the neotenic characters listed above are shared by other taxa of Lepidopsocidae showing brachyptery. Thus, they are not diagnostic in the sense of being discriminatory, but they do apply to all adults of *Cyptophania* and are important for recognition of members of the genus.

Non-neotenic characters. Antennae longer than body, with 39–47 flagellomeres; maxillary P4 broad, hatchet-shaped at tip (Fig. 5); fore wings rounded or obtusely pointed distally; fore wings bearing slender, upright scales at least in basal region, and shorter, slender seta-like scales over most of the outer surface; tibial color banding absent; preapical denticle of pretarsal claws reduced nearly to absence; pulvillus wide, blade-like (Figs 6, 42); collar of spermathecal duct with a non-terminal entry orifice, a short to medium length cap, and a distal appendage (Figs 13, 23, 24, 33, 44–46); spermathecal sac with a sword- or scythe-shaped sclerite, here called the spermathecal cutter (Figs 14, 25, 34, 47, 48); spermathecal gland stalked, either reticulate (Figs 14, 47, 48) or spongiform (Figs 25, 34); ovipositor valvulae with v1 relatively well-sclerotized (Figs 12, 26, 32, 43), but embedded among sclerotic strands in a membrane; telson lobes: epiproct semicircular with scattered setae; paraproct (Fig. 7) about 3X as long dorso-ventrally as its greatest width, slightly bowed inward on median surface, two trichobothria of sensorium near upper surface, scattered setae in middle, and large, acuminate spine on median surface.

**Characters for species discrimination.** In the present study, we find the characters discussed below as important for separation of species.

Presence or absence, and relative distinctness of whorls of microtriches on antennal flagellomeres beyond fl. Of the species studied, all showed at least a few microtriches, probably forming whorls on some median flagellomeres, but one species, *C. pakaratii* n.sp., shows very distinct whorls on all flagellomeres beyond fl (Fig. 15).

Details of the lacinial tip (Figs 8, 17, 28, 36–38). This character is of very limited value, as its variation within species is not understood, and its orientation in slide preparations is variable. Further observations on it will be necessary.

Fore wing showing venation or not. In some species, venation is obvious in a slide preparation of the fore wing (see Banks, 1931, Pl. vii, Fig. 1), whereas in others, none can be seen. This may be an aspect of variation in neotenic development (see Discussion).

Fore wing with a mottled color pattern (Figs 9, 16, 35) or not (Fig. 27), and nature of the pattern when present.

Nature of the hind wing: either a button-like swelling (Fig. 3), a minute flap of cuticle (not figured), or a short strip (Fig. 4). This may be another aspect of variation in neotenic development (see Discussion).

Extent of development of the hind coxal rasp (Figs 10, 18, 29, 39–41). This may be yet another aspect of variation in neotenic development (see Discussion).

Presence or absence of two trichobothrium-like setae on the hind tibia (Fig. 30). These structures can become dislodged, but their button-like basal tubercles are readily identified, being very different from the basal structures of other setae and scales in their region.

Hind tibial spurs striated (Fig. 22) or not (Fig. 31). In all but one of the species examined, the two large hind tibial spurs, as well as the smaller ones, showed distinct longitudinal striations. One species, *C. australica* n.sp., showed smooth spurs.

Presence or absence of ctenidia on the hind t1. In *C. hirsuta* a longitudinal row of ctenidia is present on the hind t1, each ctenidium associated with a particular seta (Fig. 11). These structures are not seen in any of the other species studied. This is another aspect of variation in the extent of neotenic development.

Presence or absence of a row of pigment spots associated with the spiracles on the preclunial abdominal segments. These spots are present in one and absent in the others of the species studied.

Sclerotization and pigmentation of one or two abdominal tergites before the clunium. Differences are noted in the descriptions for the species studied.

Ovipositor valvulae. The major valvula seems to show no useful characters. The smaller, inner valvula, here designated v1, shows some variation in its extent of sclerotization.

Details of the spermathecal cutter (Figs 14, 25, 34, 47, 48). The knife-like blade in the spermathecal sac, here called the spermathecal cutter, shows variation in relative length, thickness, and curvature among species. Some variation probably involves differences in orientation in the slide preparation.

Nature of the spermathecal gland. The spermathecal gland in *Cyrtophania* is always stalked. Branches from the stalk may serve to anchor a reticulate pattern (Figs 14, 47, 48) or produce a sponge-like mass (Figs 25, 34).

Nature of the collar of the spermathecal duct. The collar is always longer than wide, with a non-terminal entrance orifice and a subapical appendage. The relative length to width, position of the orifice, and nature of the appendage differ among species. One species has a sclerotized ‘pen’ running much of the length of the collar before the orifice (Fig. 33).

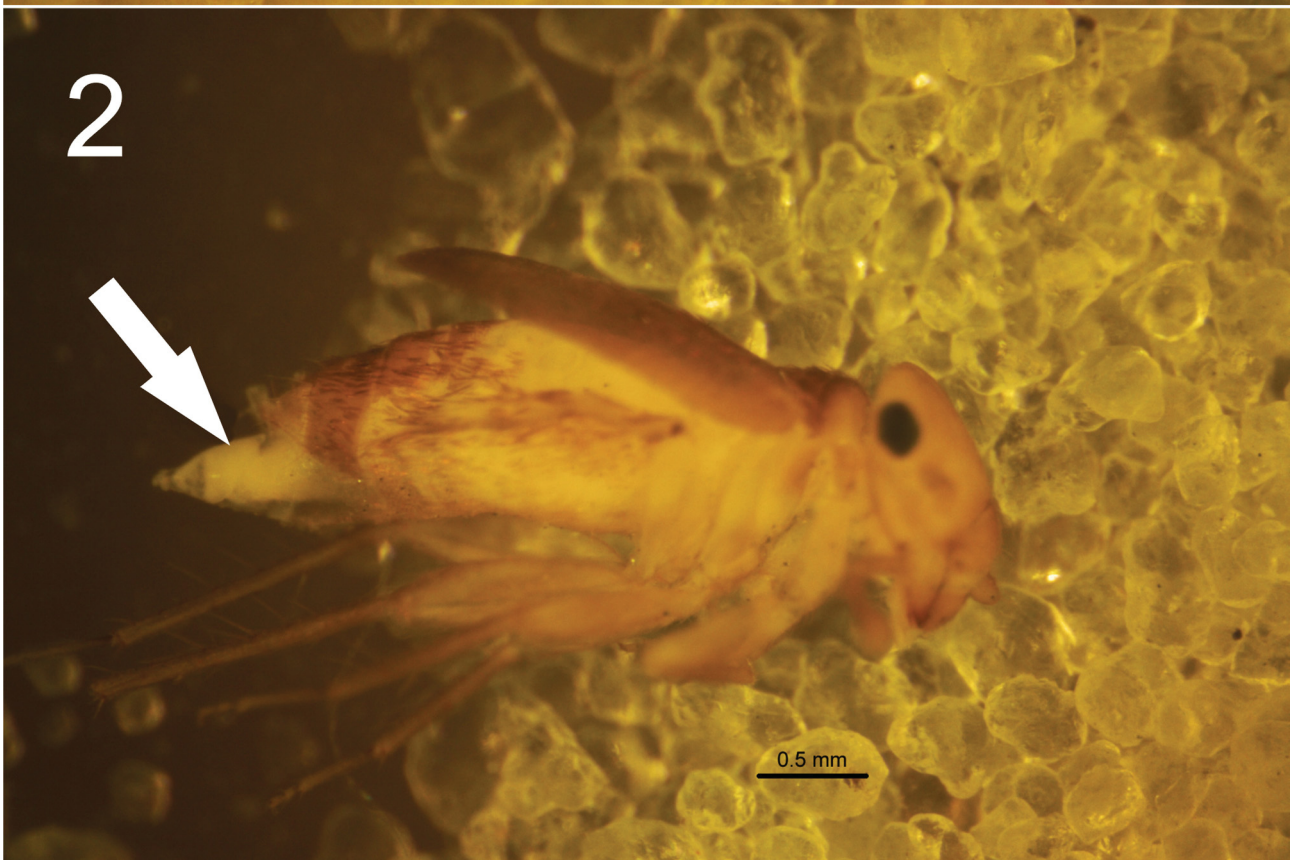
In addition to the above characters, the number of flagellomeres may be important, but the flagellum is delicate, often incomplete, and so, this character is frequently not observable. There may also be useful male characters, but since males are known for only one species, they cannot be evaluated here.

### ***Cyrtophania hirsuta* Banks**

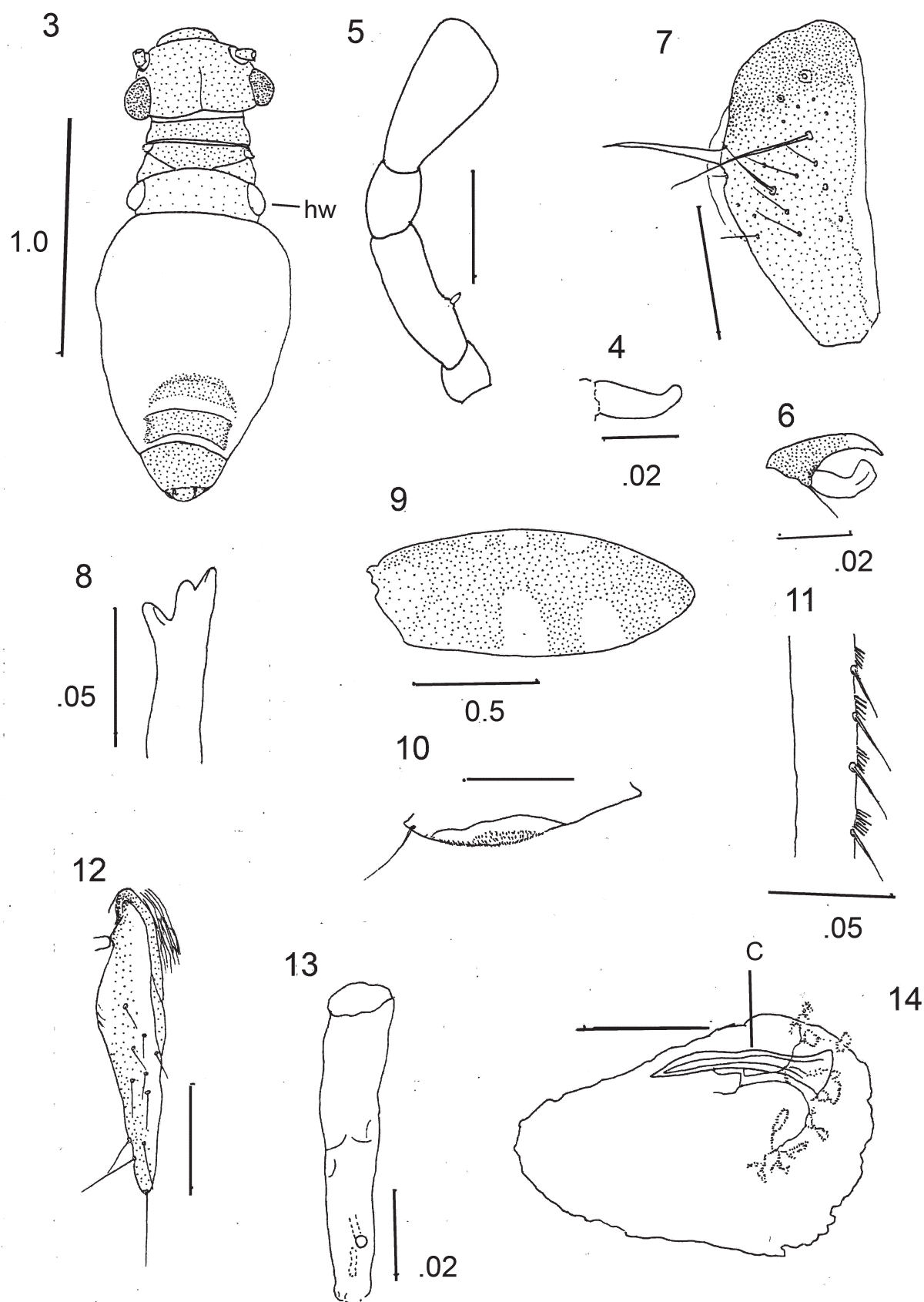
*Cyrtophania hirsuta* Banks (1931: 440, Pl.VII, Fig. 1, Pl. VIII, Fig. 7, Pl. IX, Fig. 5)

Banks (1931) provided a suitable description of the color and general form of this species, including the fore wing venation. We add below information permitting its detailed comparison with other species.

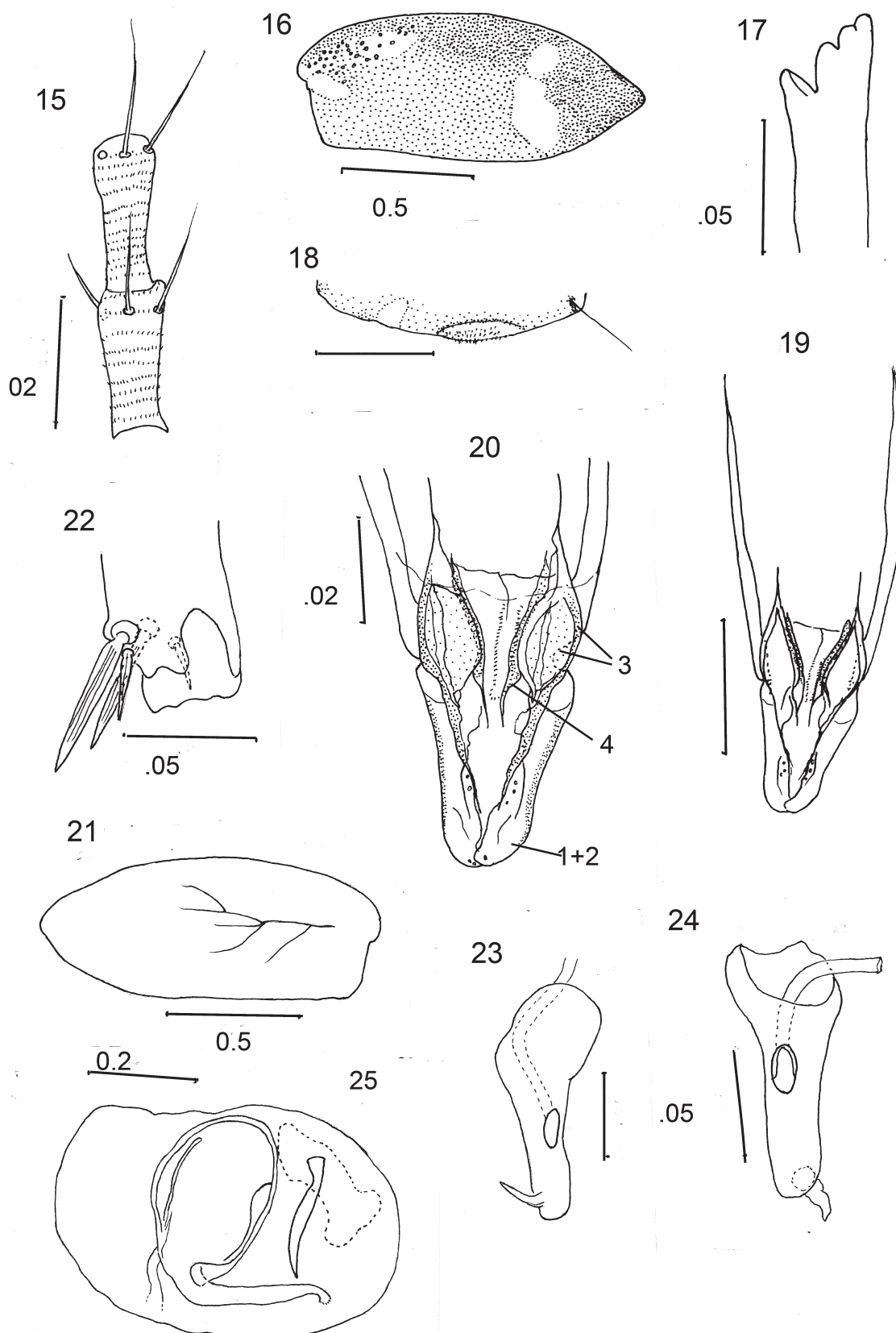




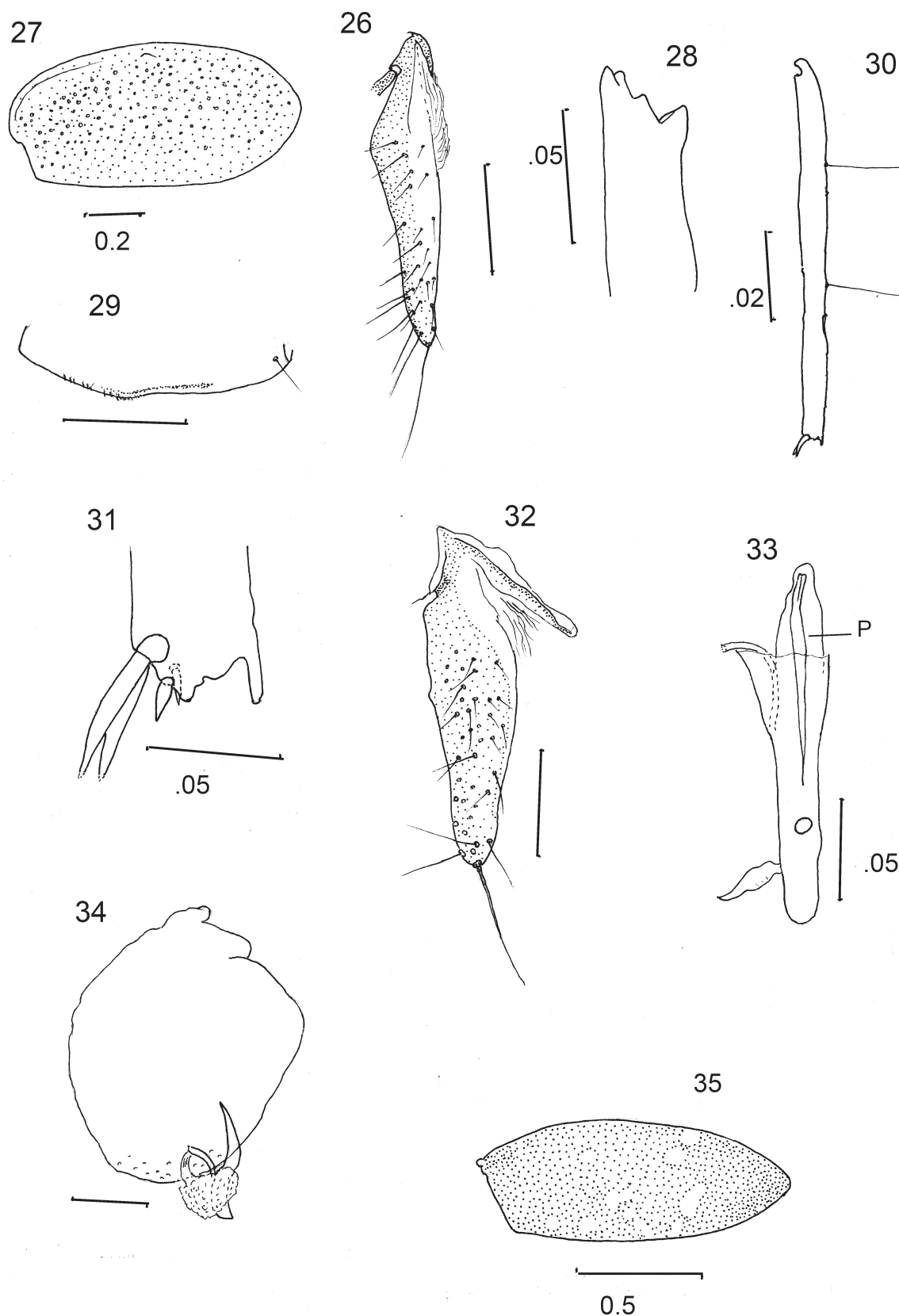
**FIGURES 1–2.** (1) *Cyptophania pakaratii* n.sp., male, habitus; (2) *Cyptophania pakaratii* n.sp., female, with spermatophore (arrow) protruding from genital chamber.



**FIGURES 3–14.** Structures of *Cyrtophania* spp. (3) *C. pakaratii* n.sp. head and body with fore wings removed, dorsal view (hw = hind wing); (4) *C. hirsuta* Banks, hind wing; (5) *C. costalis* n.sp., maxillary palpus (setae not shown); (6) *C. pakaratii* n.sp., pretarsal claw; (7) *C. pakaratii* n.sp., female, right paraproct; Figs 8–14: *C. hirsuta* Banks, female. (8) lacinial tip; (9) fore wing; (10) inner edge of hind coxa showing coxal rasp; (11) ctenidia of hind t1; (12) ovipositor valvulae; (13) collar of spermathecal duct; (14) spermathecal sac (C = cutter). Scale bars = 0.1 mm unless indicated otherwise.

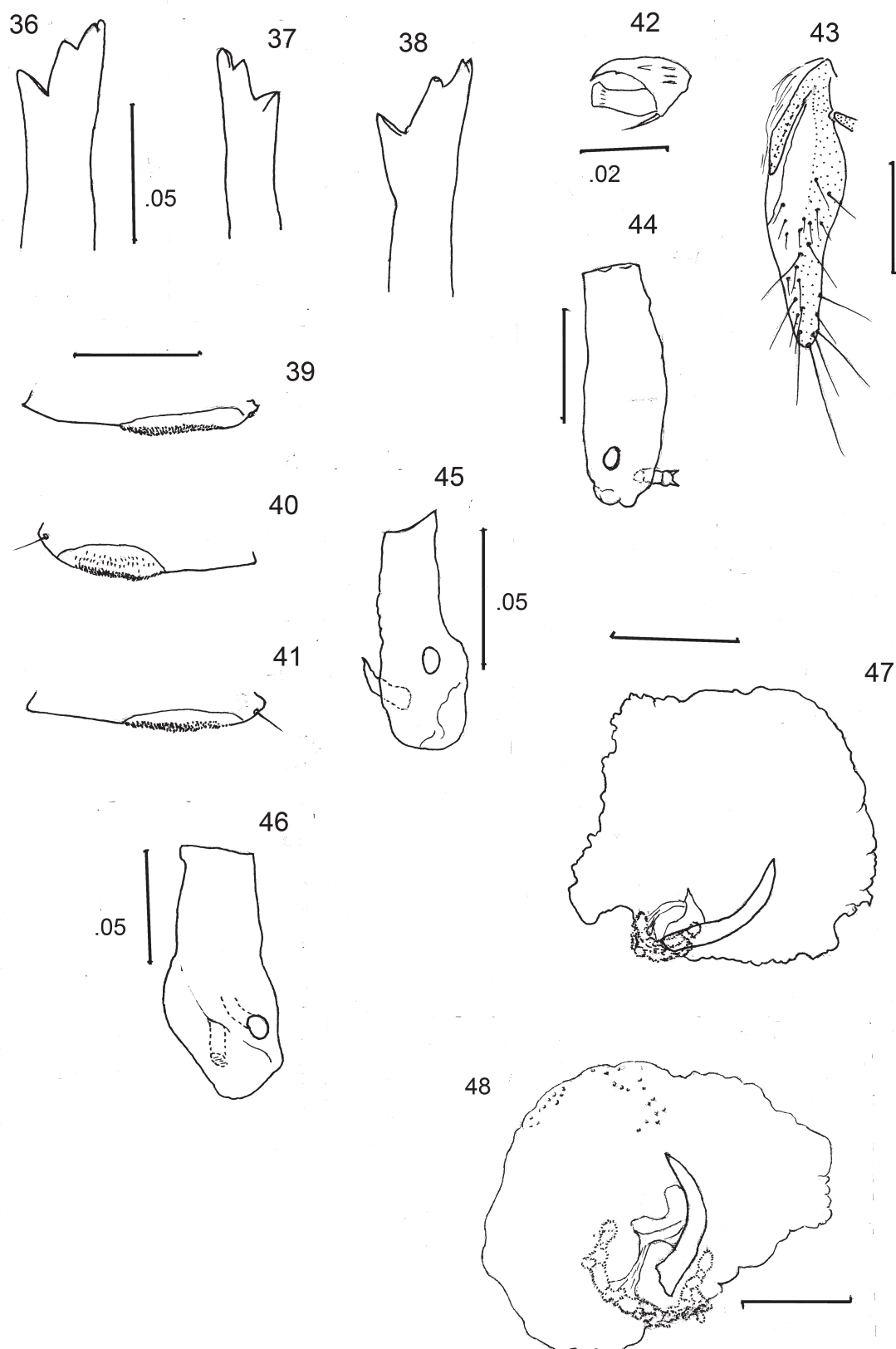


**FIGURES 15–25.** Structures of *Cyrtophania pakaratii* n.sp. (15) flagellomeres f2 and f3 showing distinct whorls of microtriches and distal whorls of setae; (16) female, fore wing showing color pattern; (17) female, lacinial tip; (18) female, inner edge of hind coxa showing coxal rasp; (19) male, phallosome; (20) male, distal end of phallosome, enlarged (see text for interpretation of labels); (21) female, fore wing showing venation; (22) female, hind tibial spurs; (23–24) female, collars of spermathecal duct; (25) female, spermathecal sac (outline of spongiform gland in dashed lines). Scale bars = 0.1 mm unless indicated otherwise.



**FIGURES 26–35.** Structures of *Cyrtophania* spp. (26) *C. pakaratii* n.sp., female, ovipositor valvulae. Figs 27–34: *C. australica* n.sp., female. (27) fore wing; (28) lacinial tip; (29) Inner edge of hind coxa showing coxal rasp; (30) hind tibia showing sub-basal and sub-distal trichobothrium-like setae; (31) hind tibial spurs; (32) ovipositor valvulae; (33) collar of spermathecal duct (P = ‘pen’); (34) spermathecal sac; (35) *C. costalis* n.sp., female, fore wing (Florida specimen). Scale bars = 0.1 mm unless indicated otherwise.





**FIGURES 36–48.** *Cytophania costalis* n.sp., female, structures. Figs 36–38: Lacinial tips. (36) San Juan, Puerto Rico; (37) Florida Keys; (38) Coastal Veracruz, Mexico; Figs 39–41: inner edges of hind coxae showing coxal rasps. (39) San Juan, Puerto Rico; (40) Florida Keys; (41) Coastal Veracruz, Mexico; (42) Pretarsal claw (Puerto Rico, but representative of each of the populations); (43) Ovipositor valvulae (Puerto Rico, no differences noted in other populations); Figs 44–46: Collars of spermathecal duct. (44) San Juan, Puerto Rico; (45) Florida Keys; (46) Coastal Veracruz, Mexico; Figs 47–48: spermathecal sacs. (47) Florida Keys; (48) San Juan, Puerto Rico. Scale bars = 0.1 mm unless indicated otherwise.



**Augmented description.** Antenna with 45 flagellomeres. Whorls of microtriches vaguely visible in basal halves of some flagellomeres from f7 outward. All flagellomeres bearing long setae (most about equal to length of their flagellomeres); these in a subapical whorl on each of f2–f19, more irregular in arrangement beyond f19. Lacinial tip (Fig. 8): lateral tine with outer denticle slightly doubled at tip, rounded inner denticle, simple median tine. Fore wing with a distinctive pattern (Fig. 9). Hind wings developed as short, slender straps, slightly longer than length of the metatergum (Fig. 4). Hind coxal rasp relatively wide, occupying about half of inner edge of coxa (Fig. 10). Trichobothrium-like setae absent on hind tibia. Hind tibial spurs striated. Twelve ctenidia present on hind t1, forming inner row (Fig. 11). One abdominal tergite before clunium strongly pigmented and sclerotized, a second weakly pigmented. Ovipositor valvulae (Fig. 12) with v1 relatively long. Collar of spermathecal duct (Fig. 13) elongate, about 5X as long as its basal width, with orifice about three-fourths distance from base to tip and a small appendage just distal to orifice. Spermathecal cutter (Fig. 14) curved horn-like in lateral view, occupying about half length of spermathecal sac in slide preparation. Spermathecal gland reticulate. Telson lobes as described for the genus.

**Female measurements** ( $\mu\text{m}$ ). BL = 1848, FW = 1399, F = 568, T = 815, t1 = 343, t2 = 63, t3 = 64, f1 = 41, f2 = 41, f3 = 44, f4 = 44, IO = 429, d = 100, D = 198, IO/d = 4.29, IO/D = 3.09.

**Material examined.** USA: Hawaii: Hawaii Co.: Hilo, Saddle Road, el. 457M, 29 August 1957, beating foliage in woodland, 3 females, coll. E. L. Mockford.

### *Cyrtophania pakaratii* n.sp.

**Diagnosis.** Antenna with distinct whorls of microtriches on flagellomeres beyond f1 (Fig. 15). Ctenidia absent on hind t1. Two tergites sclerotized and pigmented before clunium (Fig. 3). See also Key.

**Male color** (in alcohol 4 years). Compound eyes black. Rest of head, thorax, and appendages beige. Fore wings beige, darker along anterior margin and tip region, mottled with distinct colorless areas in basal and in distal one-third (Fig. 16). Preclunial abdominal segments colorless with white internal tissues showing through; persistent scales on sides brown. Terminal abdominal segments beige.

**Male structural characters.** Habitus (Fig. 1). Antenna with up to 42 flagellomeres, with distinct whorls of microtriches from f2 presumably to tip (but slide-mounted specimens with antennae missing beyond f17); with a subapical whorl of long setae, some as long as their segment, on each flagellomere. Lacinial tip (Fig. 17): lateral tine with double outer denticle, one part shorter than the other, inner denticle short and blunt; median tine simple. Fore wing venation not visible. Hind coxal rasp as in female (Fig. 18). Sub-basal and sub-distal hind tibial trichobothrium-like setae present (as in Fig. 30). Spurs of hind tibia striated. Ctenidia absent on hind t1. Two abdominal tergites before clunium sclerotized and pigmented (as in Fig. 3). Hypandrium with straight posterior margin, rounded sides, bearing scattered setae on outer surface. Phallosome (Figs 19, 20): basal struts straight, about  $2\frac{1}{3}$ X length of external parameres, each bending slightly inward distally to join base of external paramere; internal parameres not visible as distinct regions, probably fused to externals, the region of probable fusion (no. 1+2 on Fig. 20) bearing pores medio-distally; external endophallic rami (no. 3 on Fig. 20) (nomenclature of Mockford (2005)) broadened near their bases, terminating anteriorly and posteriorly in a slender filament; internal endophallic rami (no. 4 on Fig. 20) each forming a well-sclerotized curved surface along inner margin of base of external ramus and terminating apically in a slender filament; membrane between internal rami bearing two longitudinal sets of spinules. Telson lobes as described for the genus.

**Male measurements** ( $\mu\text{m}$ ). BL = 1954, FW = 889, F = 603, T = 848, t1 = 350, t2 = 62, t3 = 66, f1 = 44, f2 = 45, f3 = 46, f4 = 53, IO = 448.6, d = 112.2, D = 205.4, IO/d = 4.00, IO/D = 2.184.

**Female color** (in alcohol 3 years). Compound eyes black. Rest of head, thorax, appendages, and terminal abdominal segments medium brown. Fore wings and preclunial abdominal segments as described for male.

**Female structural characters.** Habitus (Fig. 3, wings removed, appendages and persistent scales not shown). Antenna as described for male (missing beyond f13). Lacinial tip as described for male. Fore wing venation vaguely visible at low power (40X), basal cell absent (Fig. 21). Hind wings developed as small, rounded lateral swellings on metanotum. Hind coxal rasp relatively short and slender (Fig. 18). Basal tubercles of sub-basal and sub-distal hind tibial trichobothrium-like setae present (the setae missing). Spurs of hind tibia striated (Fig. 22). Ctenidia absent on hind t1. Sclerotization of abdominal terga as described for male. Collar of spermathecal duct

(Figs 23, 24) with orifice in middle or slightly distal to middle, distal appendage a beak-like structure pointed apically. Cutter of spermathecal sac (Fig. 25) slender, sword-shaped, slightly over half as long as width (shorter diameter) of the sac in slide preparation. Spermathecal gland spongiform (Fig. 25). Ovipositor valvulae (Fig. 26) typical of the genus; v1 relatively weakly sclerotized beyond its base. Telson lobes as described for the genus.

**Female measurements** ( $\mu\text{m}$ ). BL = 2246, FW = 1329, F = 671, T = 951, hind tarsi missing, f1 = 44, f2 = 38, f3 = 50, f4 = 44, IO = 467, d = 112, D = 201, IO/d = 4.18, IO/D = 2.32.

**Material examined.** Chile: Rapa Nui, five lava tube caves of the Roiho Lava Flow approximately 5 km north of Hanga Roa Village. Materials were collected using timed searches of fern and moss gardens within collapsed pit entrances of the caves (cave codes Q15-056, Q15-067, Q15-070, Q15-076-078, Q15-074) from 30 June–13 July 2009 and bait sampling using locally occurring tree branches and sweet potato within the deep zone (see Howarth 1980; 1982) of cave Q15-074 from 02–06 August 2011. All collections by JJW and associates (see Acknowledgments), holotype female (on slide and in alcohol), 7 male and 7 female paratypes (one male the allotype on slide and in alcohol) and 3 nymphs (holotype and allotype plus 4 male, 4 female paratypes and 2 nymphs to INHS, 2 male, 2 female paratypes and 1 nymph to ELM).

**Etymology.** The species is named for Lázaro Pakarati, a spiritual leader and principal cave explorer in Rapa Nui.

Note (distribution and conservation). *Cyrtophania pakaratii* n. sp. represents the second new species described from caves of the Roiho Lava Flow. The first, *Coecobrya kennethi* Jordana & Baquero (2008), was a new species of Collembola. Both are currently known only from these caves. A surface pitfall trapping effort in 2009 (by JJW) (two sampling grids of 20 pitfall traps deployed on either side of the Roiho Flow) did not detect *C. pakaratii* (J.J. Wynne, unpublished data). Additionally, this animal was not detected during any previous entomological investigations on Rapa Nui, nor did Mockford (1972) find this psocid in materials he identified from the island. Currently, *C. pakaratii*'s distribution appears to be limited to the fern-moss gardens within the cave entrances. In two regions of western United States, moss gardens within cave entrances have been identified as relict habitats of the last glacial maximum (LGM) and support species now restricted to these habitats (see Benedict (1979), Northup & Welbourn (1997), Wynne (2013)). On Rapa Nui, we suggest that this habitat and some of the species supported within it may represent relicts of a pre-disturbance ecosystem that existed prior to the arrival of the Polynesians. To best protect this animal and the fern-moss garden habitat, we recommend roping off these areas to restrict tourist access (see Northup & Welbourn (1997) for details). Also, we recommend conducting additional surveys in other caves on the island to gain further understanding of the distribution of this animal on the island.

### *Cyrtophania australica* n.sp.

**Diagnosis.** No distinct whorls of microtriches on antennal flagellomeres beyond f1. Fore wing venation not visible. Ctenidia absent on hind t1. Two tergites sclerotized and pigmented before clunium. See also Key.

**Female color** (in alcohol 40 years). Compound eyes black. Rest of head, body, appendages, and fore wings beige. Sides of prothorax dark reddish brown. A spot of same color on each side at level of spiracle on each of preclunial abdominal segments 2–7. Fore wings unpatterned (Fig. 27) with slight suggestion of mottled clouding when viewed at low light intensity.

**Female structural characters.** Whorls of microtriches absent on flagellomeres, but some flagellomeres with vague annulations of impressed lines; all flagellomeres (f1–f21 present, but antenna not complete) with subapical whorl of long setae, most slightly longer than their flagellomere; these whorls lying farther from apex on f15–f21; f15 and f17 also with a weakly developed median whorl of setae. Lacinal tip (Fig. 28): lateral tine with 2 distinct outer denticles, short, pointed inner denticle; simple median tine. Fore wing venation not visible. Hind wing developed as a small swelling on side of metatergum. Hind coxal rasp (Fig. 29) extremely reduced, represented by a few slightly raised areas bearing microtriches. Sub-basal and sub-distal trichobothria present on hind tibia (Fig. 30). Spurs of hind tibia smooth, not striated (Fig. 31). Ctenidia absent on hind t1. Ovipositor valvulae (Fig. 32): v1 relatively strongly sclerotized. Two tergites before clunium pigmented and sclerotized. Collar of spermathecal duct (Fig. 33) with orifice about two-thirds distance from base to tip; a pen-like thickening running along one side in basal three-fifths of collar and extending beyond base of collar; distal appendage long, acuminate-tipped. Spermathecal cutter curved, scythe-shaped (Fig. 34), seen outside the sac in the two slide preparations. Spermathecal gland stalked, spongiform (Fig. 34). Telson lobes as described for the genus.

**Female measurements** ( $\mu\text{m}$ ). BL = 2148, FW = 1180, F = 623, T = 875, t1 = 319, t2 = 62, t3 = 63, f1 = 49, f2 = 39, f3 = 42, f4 = 46, IO = 444, d = 148, D = 263, IO/d = 3.00, IO/D = 1.69.

**Material examined.** Australia: Queensland: Trinity Beach, 16 km N of Cairns, 3 September 1972, sifting litter in strand woodland, holotype female (on slide and in alcohol), 2 female paratypes, and 1 nymph, ELM collector (holotype and 1 paratype to INHS, 1 paratype and nymph to ELM).

**Etymology.** The specific name refers to the species being from Australia.

### *Cyrtophania costalis* n.sp.

**Diagnosis.** No distinct whorls of microtriches on antennal flagellomeres beyond f1. Fore wing venation not visible. Ctenidia absent on hind t1. A single tergite sclerotized and pigmented before clunium. See also Key.

**Female color** (in alcohol 26–51 years). Compound eyes black. Rest of head and prothorax beige to medium brown. Other body parts and appendages medium to light brown (material from Veracruz with slightly rusty hue). Fore wing mottled with colorless areas on brown background (Fig. 35).

**Female structural characters.** Whorls of microtriches absent on antennal flagellar segments except for extremely vague whorls on some middle segments. Long setae on all antennal flagellomeres, in subapical whorls on f1–f17, the whorls becoming median and less regular on f18 outward. Lacinial tip (Figs 36–38): lateral line with distinctly double-tipped outer denticle, large, pointed inner denticle, large, pointed median line. Fore wing venation not visible. Hind wing a minute cuticular flap. Hind coxal rasp (Figs 39–41) slender to moderately broad, occupying about half of inner edge of coxa. Trichobothrium-like setae absent on hind tibia. Hind tibial spurs striated. Ctenidia absent on hind t1. Pretarsal claw with a few lateral spinelets (Fig. 42). One abdominal tergite before clunium sclerotized and pigmented. Ovipositor valvulae (Fig. 43): v1 weakly to moderately sclerotized beyond basal stem. Collar of spermathecal duct (Figs 44–46) short, its orifice near distal end; a short appendage terminating in one or two points near orifice. Cutter of spermathecal sac (Figs 47, 48) curved, occupying about half length of sac in slide preparation. Spermathecal gland reticulate. Telson lobes as described for the genus.

**Female measurements** ( $\mu\text{m}$ ). BL = 1808, FW = 715, F = 522, T = 750, t1 = 302, t2 = 58, t3 = 63, f1 = 43, f2 = 41, f3 = 46, f4 = 42, IO = 438, d = 104, D = 226, IO/d = 4.19, IO/D = 1.93.

**Material examined.** Mexico: Veracruz: Tuxpan, 16–17 August 1965, sifting litter on beach, coll. ELM, 3 female paratypes and 6 nymphs (ELM). Puerto Rico: San Juan, 14 August 1961, sifting ground litter, coll. ELM, holotype female (on slide and in alcohol), 5 female paratypes and 7 nymphs (INHS except 1 paratype ELM). USA: Florida: Monroe Co.: Boca Chica Key, 27 October 1986, coll. J. Wolff, 1 female paratype (ELM).

**Etymology.** The name refers to the coastal situation in which each of the collections was made.

Note. Minor differences can be observed among the three populations dealt with here as a single species. Among the 15 characters compared, the single Florida specimen stands apart from the Mexican and Puerto Rican specimens by having a slightly thinner lacinial tip, obvious mottling on the fore wing, and a slightly shorter and thicker hind coxal rasp. The spermathecal cutter appears to be more pointed in the Florida and Mexican specimens than in those from Puerto Rico, but that may be a question of differences in orientation on the slide preparation. Minor differences are seen in the tip of the appendage of the collar of the spermathecal duct, but these cannot be evaluated for lack of enough material. Since the differences noted are minor, and no differences were seen in 10 of the 15 characters, it seems reasonable to treat the three populations as a single species at least until additional material allows more detailed comparisons. It seems likely in view of the absence of males and the small size and wrinkled appearance of the spermathecal sac in each case, that they all represent a parthenogenetic complex found throughout the seacoasts of the area.

### Key to the species of *Cyrtophania*

1. Fore wing venation distinct and showing a closed cell in basal half of wing ..... 2
- . Fore wing venation visible but indistinct or not visible; if visible, lacking a basal closed cell (Fig. 21) ..... 3
2. Sc in fore wing arising from basal cell. Dark banding of fore wing bold. Middle dark transverse band bending twice at right angles in center (Karny, 1932, Text-Fig. 5) ..... *C. bifurcata* (Karny)

- Sc in fore wing arising from wing base. Dark banding of fore wing obscure. Middle band broad, not bending ..... *C. hirsuta* Banks
- 3. Fore wing with three pale spots in distal three-fifths of otherwise dark anterior margin ..... *C. marginata* Thornton *et al.*
- Fore wing marking not as above, either anterior margin not darker and with only one pale spot, or anterior margin darker but with no pale spots, or no marking pattern discernible. .... 4
- 4. Fore wing with no discernible marking pattern. Collar of spermathecal duct with a thickening 'pen' in basal half (Fig. 33) ... *C. australica* n.sp.
- Fore wing with a distinct marking pattern. Collar of spermathecal duct lacking a 'pen' ..... 5
- 5. Fore wing dark along anterior margin and throughout tip region, with a distinct colorless crossband before tip (Fig. 16). Sexual species with a large spermatheca ..... *C. pakaratii* n.sp.
- Fore wing uniformly pale brown except for colorless spotting (Fig. 35). Asexual species with a small, much wrinkled spermatheca (Figs 47, 48) ..... *C. costalis* n.sp.

Note: *C. alutacea* (Enderlein) is omitted, as we feel that its inclusion in *Cyrtophania* may not be justified (see Discussion).

## Discussion

The species dealt with in detail, above, show sufficient unity and uniqueness of characters so that we are confident that they form a monophyletic group, hence a valid taxon at generic level. We also feel that *C. bifurcata* and *C. marginata*, by general resemblance, probably belong here, although several critical characters remain unknown for these two species. We hesitate to place *C. alutacea* (Enderlein) here because of several features shown by the habitus figure (Enderlein (1931, Fig. 68)) of the type: f4 not broadened distally, head wide with suggestion of slight stalking of the compound eyes, mesonotum much broader than pronotum, fore wings reaching beyond tip of abdomen, and fore wings at rest meeting in a line nearly to their tips. These are not characteristic of any of the other known species of *Cyrtophania*. Enderlein (1931) originally placed this species (*Ptenocorium alutaceum*) in subfamily Perientominae because of a suggestion of similarity of the subcostal region of the fore wing to that of the genus *Perientomum*.

The species of *Cyrtophania* share with several species of the genus *Lepidopsocus* (*L. cinctus* Thornton, *L. maculatus* Thornton, Lee & Chui, and *L. magnus* Thornton examined) the following characters: a greatly reduced preapical denticle of the pretarsal claw, a widened pulvillus, a sword-shaped cutter in the spermathecal sac, and a stalked spermathecal gland which is reticulate in the *Lepidopsocus* species and in most of the *Cyrtophania* species. It seems possible, then, that *Cyrtophania* may have been derived from a common ancestor with *Lepidopsocus* or from within *Lepidopsocus*.

Presence of a large spermatophore protruding from the genital chamber of one female of *C. pakaratii* (Fig. 2) indicates that sperm transfer must be achieved by the male implanting such a spermatophore during copulation. Implantation of a large spermatophore is also the mode of sperm transfer in *Echmepteryx youngi* Mockford (personal observation of ELM), and so it may be the mode for the entire family Lepidopsocidae.

The term "spermatophore", ordinarily used in the Psocoptera literature for sperm-containing ampules within the spermatheca, is used here to refer to a large, presumably sperm-containing structure implanted by the male in the female's genital chamber during copulation. The two structures are obviously not homologs and could be distinguished by the terms ampule spermatophores and plug spermatophores.

Within *Cyrtophania*, among the species studied, one observes a transition from least neotenic to most neotenic. *C. hirsuta* appears to be the least neotenic, with fore wing venation visible, the hind wing developed as a short flap (Fig. 4), the subbasal and subdistal trichobothrium-like setae absent on the hind tibia, and ctenidia present on the hind t1. *C. pakaratii* and *C. costalis* stand in intermediate positions. *C. pakaratii* has fore wing venation vaguely defined and only partially visible in females (not visible in males), but shows the neotenic hind tibial trichobothrium-like setae, while *C. costalis* shows no fore wing venation but lacks the hind tibial trichobothrium-like setae. These two species have gone in slightly different directions on reduction of the hind wing, with *C. costalis* showing a minute cuticular flap and *C. pakaratii* showing a small, button-like swelling (Fig. 3). *C. australica* is the most neotenic, with no fore wing venation visible, hind wings developed as small swellings, presence of the hind tibial trichobothrium-like setae. As with *C. pakaratii* and *C. costalis*, it has no ctenidia on hind t1. *C. australica* also shows the weakest development of the rasp of the hind coxa, which remains rather uniform in the other species.



The trichobothrium-like setae of the hind tibia seen in adults of two of the species studied are analogous to the true trichobothria described by Lienhard (2000; 2007) in the prionoglaridid tribe Sensitibillini. The pit in which their button-like basal tubercle sits is relatively shallow. We interpret their presence in adults of *Cryptophania* as neotenic because nymphs, but not adults, of several lepidopsocid genera have them (*Echmepteryx* s. str., *E. (Thylacopsis)* sp., *Proentomum* sp.), the nymphs, though not adults, of *C. costalis* have them, and they are found in the adults of other lepidopsocid genera with reduced wings, namely *Lepolepis*, *Neolepolepis* (brachypterous form only), and *Pteroxanium* (pers. obs. of ELM).

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